Interventions to Improve Adolescent Vaccination

What May Work and What Still Needs to Be Tested

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Since the development of the "adolescent platform" of vaccination in 1997, hundreds of studies have been conducted, identifying barriers to and facilitators of adolescent vaccination. More recent research has focused on developing and evaluating interventions to increase uptake of adolescent vaccines. This review describes a selection of recent intervention studies for increasing adolescent vaccination, divided into three categories: those with promising results that may warrant more widespread implementation, those with mixed results requiring more research, and those with proven effectiveness in other domains that have not yet been tested with regard to adolescent vaccination.

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Introduction

Vaccination is a cornerstone of adolescent preventive care in the U.S. Since the introduction of routine vaccination during childhood and adolescents, it is estimated that more than 732,000 deaths and more than 21 million hospitalizations have been averted in the U.S. alone over the last 20 years as a result of the prevention of diseases by vaccines.[1] Though these successes are to be celebrated, there is still much work to be done. In fact, 2011 marked the beginning of the "decade of vaccines" in recognition of the need for efforts to expand vaccine coverage in regions of the world with low vaccine access, and to continue, and even strengthen, efforts to maintain high coverage in other areas where vaccine hesitancy and complacency have undermined vaccination efforts.[2]

Over the last decade, increased recognition that adolescents are an important reservoir of several vaccine-preventable diseases has increased attention on vaccination of this age group specifically. For example, the highest proportion of pertussis cases occurs among 11–18-year-olds,[3] ~75% of new HPV infections occur in 15–24-year-olds,[4] and 13–21-year-olds have the highest incidence of meningococcal disease outside of infancy.[5] These illnesses can affect entire communities, making adolescent vaccination against these infections a major public health priority. The "adolescent platform" of vaccines was initially developed in 1997 with recommendations for adolescent varicella, hepatitis B, tetanus, and measles–mumps–rubella.[6] Over time, the vaccines comprising the adolescent platform have changed to reflect changes in the vaccination schedule. Currently, the platform consists of four vaccines routinely recommended for all U.S. adolescents[7]: the tetanus–diphtheria–acellular pertussis (Tdap); meningococcal (MCV); human papillomavirus (HPV); and influenza vaccines. With the exception of annual influenza vaccination, all of these vaccines are preferentially recommended for 11–12-year-olds, but can be given throughout adolescence if not provided previously.[8]

Of these four vaccines, only Tdap and MCV have surpassed or nearly reached the U.S. Healthy People 2020 goal coverage level of 80%. As of 2013, Tdap uptake among those aged 13–17 years was 86.0% and MCV was 77.8%.[9] HPV vaccination levels lag significantly, with only 57.3% of girls and 34.6% of boys aged 13–17 having begun the three-dose series. Series completion is significantly lower, at 37.6% and 13.9% for girls and boys, respectively. Of concern, among girls there have been minimal increases in HPV vaccination over the last 3 years.[10] Influenza vaccination is also dismally low, with only 42.5% of adolescents receiving this vaccine in the 2012–2013 season.[11]

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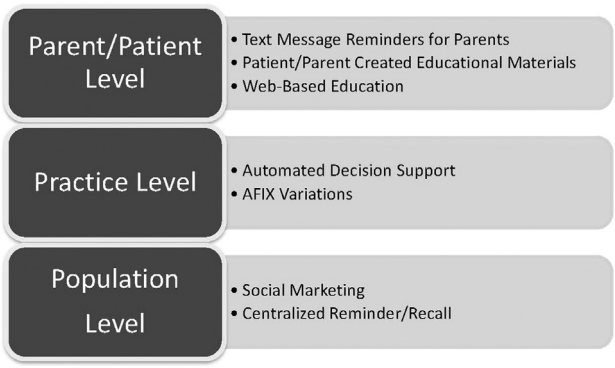

Figure 1. Tested interventions that hold promise for increasing adolescent vaccination.
Note: Potentially useful adolescent vaccination interventions discussed in this review, sub-divided by the level at which the intervention occurs.

Since the development of the adolescent platform, there have been hundreds of studies[12–23] describing the variety of barriers to vaccinating this population. This work has laid the foundation for more recent research[24–26] aimed at developing and evaluating interventions to increase adolescent vaccination. These studies have centered primarily on HPV and influenza vaccines, given their lower coverage levels. This review focuses on a selection of recent (from 2006 to present) intervention studies for improving adolescent vaccination. It includes select examples from three levels of possible intervention: parents/patients, practice, and population (Figure 1). This review specifically focuses on interventions that, in our opinion, go beyond the "usual suspects" in that they are either entirely novel, have had little prior examination, or add a twist (usually technology-related) to the standard evidence-based interventions for vaccination recommended by the U.S. Task Force on Community Preventive Services (USTFCPS).[27,28] As this is not a systematic or comprehensive review, studies related to school mandates for vaccines are not included because policy interventions such as this are outside of the scope of this manuscript. Also not included are studies focused on the provision of vaccines in schools, for example, through school-located clinics, as this large and diverse subject potentially warrants its own review.

Tested Interventions That Hold Promise for Increasing Adolescent Vaccination

The studies described below represent a selection of interventions that appear to be potentially useful for increasing adolescent vaccination. Many of these interventions use technology to support their implementation.

Parent/Patient-Level Interventions

Text messaging to parents. Parent and clinician "reminders" for vaccines coming due, and "recall" for vaccines past due, are one of several evidence-based approaches for improving vaccination endorsed by the USTFCPS.[27] Most studies of this communication strategy have focused on paper- or telephone-based reminder systems. However, with the increased use of mobile phones for health-related activities,[29] several groups have recently begun to examine the impact of text message reminder/recall on adolescent immunization. Kharbanda et al.[30] examined the impact of text message reminders for on-time receipt of first and second doses of HPV vaccine among parents of adolescents (aged 9–20 years) from nine pediatric sites in New York City. After controlling for variations in insurance and intervention implementation, adolescents of the 124 parents enrolled in the text messaging program had approximately two times the odds of receiving HPV doses on time when compared with controls. Subsequent studies found similar effects for MCV and Tdap vaccines (AORs among intervention group, 2.17–4.57, depending on the assessment time and vaccine).[31] Moreover, in a significantly larger study[32] (n=3,790 intervention, n=3,784 control), effectiveness of text messaging for improving influenza vaccination was also demonstrated (relative rate ratio=1.09 for intervention vs control), though these analyses included children aged 6 months to 18 years and did not provide adolescent-specific results. Other groups[33–38] are engaged in text messaging studies for adolescents or other populations, and it appears that a systematic review[39] on this approach will be forthcoming. Based on these studies, the use of text messaging to improve adolescent vaccination, particularly the completion of multi-dose series, seems promising.

Parent/patient-created educational materials. Patient- or parent-based education, when used without other intervention strategies, is deemed by USTFCPS as an approach with "insufficient evidence" to endorse as a strategy to improve vaccination rates.[28] However, these analyses were done primarily before newer educational modalities were used—for example, using community input to design the educational materials (i.e., creation of "patient-centered" information), or web-based tools for information dissemination.

Recently, there has been a push in health communication toward making educational materials more "patient-centered."[40–42] Patient-centeredness refers to the notion that input from the expected "end users" (in this case adolescent patients/parents) into the development of an intervention can significantly improve its acceptability and effectiveness.[42] A few studies have begun exploring patient-centered approaches to developing educational materials related to adolescent vaccination. Gargano and colleagues[43] described the

development and evaluation of a parent educational brochure about adolescent vaccines that was created in close collaboration with focus group and pilot testing feedback from parents of middle and high school students where the intervention was to be implemented. Overall, 67% of parents recalled receiving the brochure, 90% of whom read it. Moreover, more than half discussed the brochure with family or friends. The authors of this study indicate that future work will evaluate the impact of the intervention on actual adolescent vaccination levels.

A second study by Katz et al.[44] described the development of a comic book that included critical input by parents in rural Ohio as part of a multilevel intervention to promote HPV vaccination. Using an iterative approach, parents and the research team collaboratively created a storyline, text, and artistic elements that were developed into a comic book. When the comic book was evaluated among 20 additional parents, it significantly improved their knowledge and positive attitudes about HPV vaccination. Moreover, among the 19 adolescents whose parents gave permission for them to also read the book, most had positive responses to the materials and indicated that the format and information were useful and engaging. Future studies by this group will examine the impact of the comic book on adolescent attitudes and utilization of the vaccine among a larger sample.

Web-based educational materials for parents. Web-based approaches to health communication have been studied in many domains.[45–52] A few groups have examined this communication modality with regard to adolescent vaccination specifically. Starling and colleagues[53] developed a website called "GoHealthyGirls" to educate and inform parents and their adolescent daughters about HPV vaccines and infection. Beta-testing of this multimedia website among a diverse set of 63 parents and their daughters demonstrated that, after viewing the website, parents reported significantly more-positive attitudes about HPV vaccination, and higher perceived risk for HPV infection. The authors report that this website will be more thoroughly evaluated in an upcoming RCT.

Another approach that has begun to be evaluated with regard to adolescent vaccination is whether websites providing parents with "tailored" information about vaccines influence vaccine uptake. Message tailoring involves the individualization of educational materials to reflect each user's unique experiences, beliefs, and concerns. Message tailoring has been found to be an effective strategy for improving adherence with a variety of preventive health behaviors in many diverse populations, but has only recently been applied to vaccination.[54–56] Using an RCT design, our group (Dempsey et al.[57]) is examining several interventions that provide tailored material to parents about adolescent vaccines via web-based platforms such as iPads or home computers. Though final results are not yet available, preliminary results for HPV vaccines specifically demonstrate that tailored materials are superior to untailored materials for improving parental HPV vaccination intentions. A study by Gerend and colleagues[58] found similar results when tailored messages about HPV vaccination were provided to young adult women. Though these results are encouraging, the impact of tailored messaging on actual HPV vaccine utilization remains to be determined. Data in this regard should be available from our group within the next year.

Web-based communication about vaccines extends beyond viewing of content-oriented web pages. Nan et al.[59] examined the role of blogs on HPV vaccination attitudes and behavioral intention. In their study of 341 young adult men and women, they found that exposure to "negative" blogs significantly reduced perceptions of vaccine efficacy and safety and vaccination intent when compared with a control group of no blog exposure. Surprisingly, exposure to "positive" blogs had no effect when compared with controls. This work, combined with that focused on vaccination in other populations,[60–74] supports the notion that web-based social media can play a powerful role in mediating vaccination intentions and decisions.

Population-Level Interventions

Social marketing. Social marketing is a "process that applies traditional marketing principles and techniques to influence target audience behaviors that benefit society as well as the individual."[75] Its concepts include components of several health behavior theories, social psychology, marketing science, and communication research. The application of social marketing to adolescent vaccination was explored by Cates and colleagues[76,77] in two studies. In the first, social marketing principles were used to design educational materials about HPV vaccination targeted to mothers of 11–12-year-olds and distributed across four counties in North Carolina.[76] The study found modest impacts of the intervention, with HPV vaccination levels 2% higher among 9–13-year-olds in two of four intervention counties compared with 96 non-intervention counties, when assessed 6 months after the intervention period. In addition, a high proportion of mothers surveyed from the intervention counties remembered seeing the campaign materials, and the majority "took action" as a result, for example, talking with their daughter's provider about the vaccine.

The second study[77] focused on parents of preteen (9–13-year-old) boys and their healthcare providers. It included several types of parent educational materials as well as a webinar, tip sheet, and website resource list for providers. After controlling for race, age, and Vaccines For Children program eligibility, the data showed a 34% higher likelihood of receiving an HPV vaccine dose during the 3-month intervention period for boys residing in the 13 intervention counties compared with those residing in the 15 control counties. However, the effect did not appear to be sustained, as there were no differences between control and intervention groups when data were assessed after the intervention period was complete.

Centralized reminder/recall. Many studies[27,28] have demonstrated the effectiveness of parent reminder/recall strategies for improving vaccination. Typically, these interventions are instituted at the practice level and use mail- or phone-based approaches. However, with advances in computerized records and immunization information systems, a novel innovation of reminder/recall is "centralizing" the process such that a coordinating agency (i.e., health department), rather than an individual practice, implements the service. Centralized reminder/recall for adolescent vaccination at the population level has begun to be examined. Szilagyi et al.[78] implemented a centralized reminder/recall approach (telephone or postal mail) via a managed care organization (MCO) in a study that assessed all four vaccines in the current adolescent platform and included 4,115 adolescents (aged 11–17 years) seen at one of 37 primary care practices in central New York. Both the telephone and postal mail arms of the study had immunization levels that were 4–9 percentage points greater than the control group (no reminders) for each assessed vaccine. These increases in vaccination are similar to those found in other mail-based reminder/recall studies, but required significantly less effort on the part of practices to implement. A similar finding was published recently by Chao and colleagues,[79] who reported a three-dose completion rate nearly 10% higher in a reminder letter group compared with a control group. By contrast, Patel et al.[80] found that an automated reminder system did not increase HPV vaccine completion rates. It may be that more work needs to be done to determine the most effective ways to implement these kinds of reminder/recall systems.

A study by Kempe and colleagues[81] compared practice-based versus population-based recall directly, though the focus was on children aged 19–35 months. In this study, the intervention group consisted of seven counties in Colorado where reminder/recall was implemented by local county health departments using the state immunization registry. The control group consisted of primary care practices in seven additional counties that were invited to do practice-based reminder/recall using the immunization registry, with training available if desired. Overall up-to-date vaccination status was approximately 6 percentage points higher among children in the intervention versus control counties ($p < 0.001$). However, an important finding of the study was that only 5% of practices in the intervention arm actually implemented practice-based reminder/recall strategies. This latter finding further supports the utility of centralizing the vaccination reminder/recall process.

Practice-Level Interventions

Automated clinical decision support. A recent meta-analysis[82] of automated decision support tools such as on-screen "practices alerts" embedded within the electronic medical record (EMR) at the point of care demonstrated a 3.8% improvement in vaccination adherence generally. Several groups have examined the role that practice alerts can have on improving adolescent vaccination specifically. In an initial study, Mayne et al.[83] demonstrated that implementing a practice alert for HPV vaccination in the EMR of 11 pediatrics practices in Philadelphia resulted in a higher proportion of parents reporting they had discussed the vaccine with their child's provider, compared with parents from practices that did not have the alert in place (84% vs 70%, $p=0.02$). In a larger RCT of this intervention, the clinician-focused practice alert resulted in HPV vaccination initiation levels that were 8 percentage points higher than in offices with no intervention in place (24% vs 16%), and 6 percentage points higher than in offices where a family-focused educational intervention was provided instead (18%).[84] However, for subsequent HPV vaccine doses, the family-focused intervention was more effective than the practice alert intervention.

In a separate study, Stockwell and colleagues[85] used a randomized cluster-crossover design to evaluate the impact of EMR-based practice alerts for influenza vaccination among children (aged 6 months to 17 years) seen at four primary care clinics in New York City. They found a measurable increase in influenza vaccination during periods when the reminder was active compared with when it was not (76.2% vs 73.8%, $p=0.27$), with greater effects present in the later months of the influenza season. However, the authors did not report on whether there were any differences in the intervention's effect by patient age, precluding conclusions about this intervention for adolescent vaccination specifically.

Another recent study by Perkins et al.[86] evaluated a multicomponent practice intervention involving multiple

visits to practices, education on HPV-related health consequences and HPV vaccine safety and efficacy, feedback on vaccination rates relative to other practices, and maintenance of certification rewards for improving practicewide HPV vaccination rates. They reported sustained increases in HPV vaccination rates of female and male 11–21-year-olds in intervention compared with control clinics.

Assessment, Feedback, Incentives, and eXchange variations. Assessment, Feedback, Incentives, and eXchange (AFIX) describes another evidence-based practice recommended by the USTFCPS to improve vaccination levels.[27,28] AFIX generally involves a public health worker collaborating with practices to systematically assess vaccination levels, share this information with the practice, negotiate incentives for improvement, and exchange best practices between clinical sites. Past experience demonstrates that AFIX strategies can boost vaccination substantially.[8] However, a limitation of the "classic" AFIX approach is its resource intensiveness, with in-person interventions being the norm. Three studies, all by the same research group, have begun exploring "virtual AFIX" strategies focused on adolescent vaccination. In the first, which included 17 federally qualified health centers in North Carolina serving 7,800 adolescent patients, clinic coordinators from each center attended a 1-hour, one-on-one webinar-based "AFIX visit" by a staff member from the state health department's immunization branch.[87] Part of this visit also provided training on how to use the state's immunization registry to generate adolescent vaccination reminder letters for patients not up-to-date. Assessment at the 1-month post-intervention period demonstrated a 1%–2% increase in the proportion of adolescents up-to-date with recommended adolescent vaccines when compared with pre-intervention. Though the increase was modest, the authors concluded that these gains were significant when balanced by the substantial reduction in personnel time afforded by the virtual process. A follow-up study included 91 primary care clinics that were randomized to receive an in-person AFIX consultation, a virtual AFIX consultation, or no consultation.[88] At the 5-month follow-up assessment, it was found that the in-person and virtual AFIX consultations were equally effective for improving adolescent vaccination, and both were better than no consultation. The impact of AFIX was greatest for younger adolescents, with vaccination levels among 11–12-year-olds 1.5%–4.7% higher in either AFIX arm (depending on the vaccine assessed) when compared with the control arm. A process evaluation comparing the in-person and virtual AFIX strategies demonstrated that the latter was significantly less expensive ($100 vs $152 per clinic).[89]

Tested Interventions With Mixed Results Deserving Further Investigation

Significantly fewer articles have been published on "negative studies"—that is, studies where the intervention appeared to have had little to no effect on adolescent vaccination rates. Because of this, it is difficult to classify them by their level of intervention (patient/parent, practice, population). Instead, we have classified these interventions by type into two categories: free vaccines/financial incentives and parent education alone.

Providing Free Vaccines/Financial Incentives

Reducing out-of-pocket costs for vaccination, for example, by providing vaccines for free, is another recommended, evidence-based strategy to improve vaccination rates.[27,28] To our knowledge, there has been only one U.S.-based study that has examined the use of free vaccines on adolescent vaccination.[90] Broader studies published on adolescent and young adult HPV vaccination suggest a limited effect of providing free vaccines.[82,90] However, methodologic challenges make interpretation of these studies difficult (e.g., provision of free vaccine may be confounded with SES and other factors that may be associated with initiation or completion of the three-dose series).

With respect to incentivized vaccination, Mantzari and colleagues[91,92] performed an RCT in England that examined the impact of providing a $73 shopping voucher ($29 for first dose, $7 for second dose, $29 for third dose) on HPV vaccine series initiation and completion among girls aged 16–18 years. Text message reminders for second and third doses were also provided. The intervention led to significant and substantial increases in series completion, with double to quadruple the rates found in the control condition (22.4% vs 12% in girls not previously contacted and 12.4% vs 3% in previous non-responders). The relatively low overall completion rates, however, indicate that other approaches in addition to incentives may be required to achieve high vaccination rates. Finally, a systemic review by Wigham et al.[93] on the influence of financial incentives to parents for increasing preschool vaccination found insufficient evidence to conclude this strategy was effective, suggesting more research may be necessary to fully understand the effectiveness and cost effectiveness of incentivized HPV vaccination.

Parent/Patient Education or Messaging Alone

The type of adolescent vaccination interventions with the largest number of studies is parent/patient education or messaging alone (i.e., without other intervention components). Most of the studies in this domain focus on HPV. Results in this area are quite mixed, with some studies showing a positive effect and others showing no effect. However, a recent systematic review by Fu and colleagues[94] of educational and messaging interventions specifically to increase HPV vaccine acceptance included 33 articles, most of which were published prior to the vaccine's licensure in the U.S. The review concluded that there was insufficient evidence for recommending any specific parent or patient educational approach for improving HPV vaccination intentions, though the authors did note that, in general, such interventions appeared to be more effective when targeted to adolescents rather than their parents. Two recent messaging studies deserve mention here. One study[95] found that asking parents a rhetorical question (e.g., *Do you want to protect your daughter from cervical cancer?*) led to greater intention to vaccinate, but this increased intention did not translate into higher vaccination rates (the intervention was delivered by phone, not in a clinical setting). Another recent study[96] found that a brief messaging intervention emphasizing male-specific HPV vaccine benefits and altruistic motivation led to higher HPV vaccine acceptability among a sample of college men, but effects on actual vaccination rates were not examined. Brief messaging interventions may increase intentions, but likely have a relatively short-lived effect on behavior. Future research should examine the effects of such interventions when delivered in a clinical setting where HPV vaccine can be delivered shortly after messaging is complete.

Interventions That Have Worked in Other Settings but Have Not Been Tested in Adolescents

Below, we describe two strategies that studies suggest may be useful for improving compliance with adolescent vaccination but have not yet been rigorously tested. These interventions may be useful targets for future research.

Provider Training on How to More Effectively Talk About Vaccines

One promising area for future intervention research relates to improving provider communication strategies for adolescent vaccination, particularly HPV and influenza, by providing training and materials that providers can use when they encounter vaccine-hesitant parents. Studies of vaccination conversations between providers and parents of young children (aged 1–19 months) demonstrated that parents had a significantly higher odds of resisting vaccine recommendations when providers used a "participatory" approach (i.e., "So, what do you want to do about shots?") rather than a "presumptive" approach (i.e., "We need to do some shots today.").[97] In keeping with this finding, strong provider recommendation has been shown as a key factor in adolescent vaccination in numerous studies.[98–107] However, research demonstrates that physicians discuss some adolescent vaccines, particularly HPV, differently than others.[104,108–110] Given this, recent research has begun to focus on provider interventions to train them to talk about all adolescent vaccines in a way that is more conducive to vaccine acceptance and to use proven communication strategies such as motivational interviewing[111,112] when vaccine hesitancy is encountered.

Providing Vaccines in Pharmacies

Pharmacies are increasingly becoming a vaccination site, as they provide convenience and access on "off" hours such as weekends and evenings.[113] Adults are the greatest users of pharmacy vaccination services, but many communities also provide vaccines to adolescents.[114] Influenza vaccines are the most commonly administered vaccine in pharmacies, but other vaccines are also available.[115,116] Several intervention studies[117–119] demonstrate that pharmacy-based vaccination can be effective at improving adult vaccine coverage. Some groups[115,120] have recently begun to explore the potential for pharmacies to improve adolescent vaccination, particularly for HPV. Multiple barriers have been identified, including reimbursement for vaccination and tracking of provided vaccines.[115,121,122] However, given the proven success of pharmacists as vaccinators of adults, finding ways to implement a similar approach for adolescent vaccination may be a fruitful area for future study.

Conclusions

A variety of approaches toward increasing adolescent vaccination rates have been evaluated, with much emphasis, understandably, on HPV vaccination. Several show promise, others appear to have minimal effect, and still others show mixed results. Research findings are consistent across studies that weak or no recommendations from healthcare providers are primary drivers of poor HPV vaccine uptake. As a result, it will be important to continue to develop and evaluate interventions that target practices and healthcare providers,

including automated EMR-based reminder systems and improving provider communication skills.

Educational interventions directed at parents and adolescents may not be hugely effective. However, recent research[123] indicates that many parents remain unaware that HPV vaccine is routinely recommended for boys as well as girls. Without such awareness, these parents would not know to ask for their sons to be vaccinated. Message-framing interventions directed at parents, adolescents, and young adults show promise, particularly around increasing intentions to vaccinate. There is some evidence, however, that the effect of brief messages may be time-limited. Therefore, it will be important to evaluate the effect of different messaging strategies on parent/patient activation and vaccine receipt, when the messages are delivered in a setting where vaccines can be delivered.

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